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TYPES OF CUBAN TOBACCO

HEINRICH HASSELBRING

(WITH PLATES IV–X)

One of the most persistent ideas in evolutionary writings which deal with cultivated plants is that transferring a plant from one region to an entirely different one, or from one environment to another, is accompanied by unprecedented variability during the first season of growth after the transfer. The phenomenon is generally described as "breaking up of the type."

When Cuban tobacco seed is grown in the United States, the crop produced is not uniform, but consists of a mixture of many different forms. SHAMEL,[1] who has made extensive experiments with the introduction of Cuban tobacco into the United States, describes this phenomenon and attributes the appearance of a diversity of forms from the imported seed to the variability induced by the new environment. Regarding the variability of plants from seed imported from Cuba and Sumatra, SHAMEL and COBEY[2] say:

> The plants grown from this freshly imported seed broke up into many different types. . . . . This breaking up of type is due to the effect of the change of soil and climatic conditions, resulting in striking variation in the plants grown from the imported seed. The variation is particularly marked where southern seed is taken to northern tobacco districts.

Similar views are expressed in the older literature. Thus LOCK,[3] speaking of the importation of Havana tobaccos into other countries, says:

> There is no great difficulty in raising plants of these varieties, but they speedily degenerate and form new varieties, if the climatic conditions, etc., are not favourable.

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[1] SHAMEL, A. D., The improvement of tobacco by breeding and selection. U.S. Dept. Agr. Yearbook 1904:435–452. *pls. 7. figs. 2.*

[2] SHAMEL, A. D., and COBEY, W. W., Varieties of tobacco seed distributed in 1905–1906, with cultural directions. U.S. Dept. Agr., Bur. Plant Ind. Bull. 91. pp. 38. *pls. 9.* 1906.

[3] LOCK, C. G. W., Tobacco: growing, curing, and manufacturing. London. 1886. pp. 32.

Recently similar phenomena have been described by COOK[4] and his collaborators as occurring in cotton when transplanted from one locality to another. It is evident from these citations that it is a common belief that plants, when transported from one environment to another entirely different one, tend to break up into a number of new types. This view is held by many writers, especially regarding tobacco.

During the years 1907 to 1909, while connected with the Cuban Experiment Station at Santiago de las Vegas, I was able to gather a number of facts and to carry out some experiments which lead to a different interpretation of the phenomena observed when Cuban tobacco seed is imported and grown in the United States. The results of these observations and experiments are given in this paper. For a complete understanding of the phenomena in question, three phases of the subject are considered: (1) the composition of so-called Cuban tobacco; (2) the special methods of agriculture which tend to influence or maintain the present composition of Cuban tobacco; and (3) cultural experiments with types of Cuban tobacco.

The composition of Cuban tobacco

Even a casual survey of the tobacco fields of western Cuba shows that the crop in any field lacks entirely that uniformity which is characteristic of any field of plants of one variety in regions of more advanced agriculture. The plants show a great variety of forms, which at first seems bewildering. Upon closer study, however, it is seen that some types predominate. Most of the plants may be divided into groups, the members of which resemble each other more or less. It is impossible, however, to delimit such groups definitely, or to class all the plants into groups by a taxonomic study. Certain types are well marked, but the number of minor forms, differing in width and length of leaves, habit, branching, etc., is so great that the whole appears to be a mixture of innumerable intergrading forms. While, as has been stated, some of the forms occur with great frequency and form the predominating elements of the mixture, others are rarer, although distinctly marked Some of the more striking forms can be recognized and described taxonomically, but for the majority of the intergrading forms cultural work is necessary in order to determine their constancy. The condition here described exists, so far as I have been able to determine by examination of the fields or by growing seeds from different sources, in all the tobacco fields of western Cuba, or the regions known as the Vuelta de Abajo and the Partidos districts. It is not likely that the tobacco fields of the eastern district will be found to differ in composition from those of the other regions. The condition shows that there has been no systematic effort directed toward the amelioration and improvement of the tobacco plant in Cuba. The persistence of the present condition is explained by the special methods of agriculture in vogue in Cuba.

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[4] COOK, O. F., Local adjustment of cotton varieties. U.S. Dept. Agr., Bur. Plant Ind. Bull. 159. pp. 75. 1909.

COOK, O. F., MCLACHLAN, A., and MEADE, R. M., A study of diversity in Egyptian cotton. U.S. Dept. Agr., Bur. Plant Ind. Bull. 156. pp. 60. *pls. 6.* 1909.

Methods of agriculture

In the regions of Cuba which have been long under cultivation, great difficulty is experienced in growing *posturas*, or young tobacco plants. The soil is so thoroughly infected with fungi that a rain at any time during the season for growing *posturas* is sure to result in the entire destruction of the plants in the seedbeds. I have seen many acres of seedbeds in the finest condition destroyed in a few days by fungi following a heavy rain. As a result of this, it is customary to grow a large part of the *posturas* in the newer lands in the mountains, in soil which is partly sterilized by burning brush on the surface. The *posturas* are tied in bundles, which are packed in large bales and sent to the various tobacco districts of the island. Any grower who has lost his *posturas* makes up the supply by purchase from the mountain growers. Many growers depend entirely on these mountain-grown *posturas*, seed for which is gathered in various parts of the island. Whether the grower is gathering seed for sale or for his own use, no attempt is made to select seed from the best plants. All the plants in the fields are topped and harvested. It is not even customary to allow any of the plants to flower on the main stem and produce seed. After the harvest of the leaves, the stems are cut off close to the ground, and the field is abandoned, receiving no further irrigation, which is necessary during the growing period of the crop. As a rule, there is sufficient moisture in the soil to produce a crop of suckers from the old roots. These make a weak growth among the weeds of the abandoned fields and produce flowers and seeds. It is this crop of suckers which furnishes the seed supply for the new crop of tobacco.

Under these conditions, any form of selection is impossible, for the sucker shoots do not show the characteristics of the parent plant. When the seed is mature, all forms, good and bad, are indiscriminately gathered and resown the following season.

These methods of obtaining seed and growing *posturas* bring about two results: (1) all types of tobacco that occur in Cuba are maintained there by the blanket method of harvesting seed indiscriminately from all kinds of plants; and (2) by reason of the traffic in *posturas* and seeds, all types are distributed to all the tobacco-growing regions, so that a uniform mixture of types is maintained over the island.

Cultural experiments

As has been stated, a study of the plants in the field is not sufficient to disentangle the mixture of types and lead to exact information regarding their constancy. To determine whether these types are constant, or whether Cuban tobacco possesses the enormous variability usually attributed to it, cultural experiments were begun in 1908. During the tobacco season of that year, about 30 plants were selected which seemed to represent distinct types. A careful description, recording all characteristics that might be of any value in identifying the types, was written for each plant. The plants were staked and labeled and given a number. Inasmuch as the plants had been topped, it was necessary to save seed from the suckers which appear at the base of the plant after the stem is cut. A number of the plants did not form suckers, so that only 14 plants remained. The suckers selected for seed were inclosed in manila bags in the usual way, while the others were cut as soon as they appeared. In this way, guarded seeds from 14 isolated, self-fertilized mother plants were obtained.

In harvesting and separating the seeds from the capsules, of course every precaution was used to avoid mixing the different types. Each bag was taken separately and the seed shelled out in a large porcelain evaporating dish in the laboratory. The different lots were handled in such a way that there was no possibility of a stray seed being blown or scattered among those of another lot.

Similar precautions were used in sowing the seeds the following autumn at the beginning of the next tobacco season. The seeds were sown in flats, in soil taken from a nursery where no tobacco had been grown, and distant from any tobacco field. The soil was sterilized with hot water. After the seeds were sown, the flats were covered with burlap frames, and were protected from ants, which carry off the seeds, by a ridge of powdered naphthalene around the edge of each flat. The posts supporting the benches on which the flats stood were kept wrapped in cloth soaked in crude oil. The benches had been previously freed from ants by boiling water. With these precautions, no trouble was experienced from the insects. The flats were kept in an open shed.

The seeds were sown September 16 and 18, 1908. When the seedlings were large enough, they were pricked out in open frames kept covered for a time with canvas. The *posturas* were planted in the field at various times from November 12 to December 9, 400–500 plants of each type being set out.

The results of the cultures were so striking and uniform that they can be stated in a few words. Even in the open frames the various groups of plants showed differences which made them stand out from each other, but the differences were more evident when the plants were mature. The descendants of each plant were entirely uniform and like the parent plant from which they were derived. Even minute and unimportant characters were transmitted with surprising definiteness.

While the different types were indiscriminately intermingled in the field, the contrast even among extreme types was obscured on account of the many apparently intergrading variations, but in the cultures where large numbers of each type were grouped together the differences were unmistakable. Thus, for instance, the different groups as a whole showed marked differences in height, a characteristic which was not evident in the field, where owing to individual variation the stature of a plant is not a pronounced characteristic. Yet when the descendants of individual parent plants were brought together in groups under uniform conditions, the contrast in stature between the different groups was constant and very marked.

The more important morphological characteristics in which the various types differed from each other were the shape of the leaves and flowers, and the form of the inflorescence, but the descendants of a single parent were entirely uniform with respect to these characteristics. Even such minor characteristics as the tint of the leaves and color or shade of the flower were uniform throughout the plants of each group. In some cases the same type had been selected more than once, so that some of the groups were identical. The plants in the field were studied during their entire growing season, and each individual was often examined, but among the several thousand plants no aberrant form occurred.

The uniformity of the descendants of each of the parent plants indicates that the plants originally selected represented elementary species, for if the parent plants had been hybrids, splitting according to Mendel's law, the splitting should have occurred in the generation of 1909. The absence of hybrids among the plants selected can be explained by the ease with which self-pollination takes place, and by the scarcity of pollinating insects. The flowers are slightly proterogynous, but even before the flowers are fully open the anthers begin to shed their pollen. As both pistils and stamens are about equal in length, self-pollination is easily accomplished. Pollinating insects seem to be rare. During the two seasons in which I spent much time in the tobacco fields, I observed only in a few instances honey bees and hawkmoths pollinating flowers. It seems very likely, therefore, that in the majority of cases the tobacco flowers in Cuba are self-pollinated.

In order to continue the pure line cultures, a large number of plants of each type were bagged for seed in the usual way, but on account of my removal from Cuba in the spring of 1909, seeds from all the types were not obtained. Some clusters with mature seeds were found on 11 of the types. The seeds from 10–15 plants of each of these types were collected and brought to the United States. These seeds were grown at Flint, Mich., during the summer of 1910.

It is in the first crop from seed imported from Cuba that the splitting of the type into numerous varieties has often been reported. The plants in the pure line cultures in Michigan, however, showed no signs of such splitting. The plants resulting from the mixed seed of 10–15 plants of each type were entirely uniform and similar to each other. In all their important morphological characteristics they were identical with their parent plants grown in Cuba the year before. In some minor characteristics some types differed from the plants grown in Cuba. The leaves were of a darker green and the plants generally were taller and more vigorous in the more fertile soil of Michigan. In so far as there was any detectable influence due to the new environment, all the plants of a particular type reacted alike.

Discussion

It appears from the foregoing experiments that when pure strains of tobacco are selected from the mixture grown in Cuba and brought into a new environment in the United States, these pure strains show no breaking up of the type due to the new environment. The slight changes which are observed in the plants affect all the plants of one type alike.

The effects observed by SHAMEL and COBEY and others are attributable to the fact that the seed was derived from a mixture of types. Since a great number of types occur in the fields of Cuba, it is not necessary to invoke the doctrine of "breaking up of types" to account for the appearance of numerous varieties when Cuban seed is sown in the United States.

The same principle applies to tobacco and other plants cultivated in countries where agriculture has not reached a high state of development, and where the concept of an agricultural or horticultural variety hardly exists. In Cuba I have cultivated tobaccos from a number of districts in Mexico, and find that these are also mixtures of types which resemble in their general appearance the Cuban types and probably belong to the same group of elementary species. Recently Howard and Howard,[5] in their excellent studies on Indian tobaccos, have isolated 51 types from the tobaccos grown in India, and have shown that these types remain constant even in minute and insignificant characteristics when propagated in pure line cultures. Shamel[6] also has found and repeatedly emphasized the fact that when seed is obtained from single self-fertilized mother plants, the progeny is entirely uniform. In one instance he reports that plants from Florida-grown Sumatra seed showed great variability for two generations when grown in Connecticut, the seed being collected in the ordinary way from many plants, but when seed was saved from single mother plants in the second generation of northern grown plants the offspring of these plants were uniform. The variability continued for two generations, but when seed was collected from isolated plants the environment had no further effect!

Cook[7] found an exactly analagous behavior in cotton. When seed was saved from individual mother plants selected from the diverse forms of King cotton grown at San Antonio, Tex., the offspring of these forms were either uniform or showed definite types of variation. The occurrence of definite types of variation would seem to indicate that the parents were hybrids.

It is scarcely believable in either the case of tobacco or of cotton that a single selection would destroy the plant's capacity for being affected by its environment. In tobacco variation has been reported to persist at least during two generations in the new environment, yet from individual plants selected at any time a pure progeny was obtained. All such facts are more easily understood on the basis that the seed was derived from mixed parents.

It is true, of course, that plants are modified in their fluctuating characteristics by changes in the environment, but so far as experimental evidence shows, such modifications persist only as long as the environment inducing them persists. Le Clerc and Leavitt,[8] in their work with wheat, showed that this influence of the environment is exerted also on the chemical composition of plants. When wheat of one variety from one locality was grown in other localities, with a widely different environment, the chemical composition of the grain was different in each locality. These differences persisted as long as the wheat was grown in the particular locality, but if at any time seed from one locality was grown in any of the others, the grain took on the composition of the wheat constantly grown in those localities. The tobacco plant is extremely susceptible to changes in the environment, but such changes affect all the plants of a pure strain alike, and do not cause a breaking up of the type. Among the plants grown in Michigan, some of the types showed a different shade of green from that shown by the same types in Cuba, but all the plants changed alike.

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[5] Howard, A., and Howard, G. L. C., Studies in Indian tobaccos. Mem. Dept. Agr. India (Bot. Ser.) **3**:59–176. *pls. 58.* 1910.

[6] Shamel, A. D., *loc. cit.*, Yearbook. 1904.

[7] Cook, O. F., *loc. cit.*

[8] Le Clerc, J. A., and Leavitt, S., Tri-local experiments on the influence of environment on the composition of wheat. U.S. Dept. Agr., Bur. Chem. Bull. 128. pp. 18. 1910; rev. in Bot. Gaz. **50**:153. 1910.

Description of the types

The taxonomy of the TABACUM section of the genus *Nicotiana* is endlessly confused, and it is not possible from the materials at hand to give a proper classification of the forms involved in these studies. Many of them are undoubtedly well defined species. The facts that they have maintained themselves for a long period of time, that no effort has been made to improve them, and that they resemble races from Mexico, seem to indicate that these forms are not far removed from the original wild species of tobacco. As their definite classification would require the study of vastly more material than is at my disposal, it seems best to indicate the general relationships of the types and give the main characteristics by which they were distinguished. For similar reasons, it is useless to speculate on the origin of the forms of tobacco which now occur in Cuba. Many of the growers have a vague idea that the tobacco of today is not the real Cuban tobacco famous in former times. It is a common belief among them that during the long wars tobacco growing was almost exterminated on the island, and that subsequently tobacco was imported from Mexico, Porto Rico, and other regions. It is more probable, however, that even in early times the tobacco of Cuba consisted of a mixture of forms. As early as

1722, LABAT[9] describes four forms cultivated on the islands of tropical America, and it is quite probable that these were generally distributed over the islands.

In the following pages a brief description and history of the 11 types cultivated both in Cuba and Michigan are given. In designating the types, the same numbers are used by which they were designated in the cultures. In the accompanying plates showing leaves of the different types, each type shown is represented by all the leaves of a single plant of that type.

Broadly speaking, the types may be divided into two groups. The plants of the first group are characterized by broad, rounded leaves, short in comparison with their width, and scarcely or not at all pandurate, but sessile by a broad base and decurrent auricles; or the lower leaves contracted into a somewhat pandurate shank. The base or shank of the leaves in general is not as much wrinkled as in the second group. The upper small leaves on the stem and subtending the branches of the inflorescence are ovate, acute, or barely acuminate. The corolla tube is suddenly inflated just above the middle, and the limb is pentagonal and obscurely or scarcely lobed, the lobes being apiculate. The plants of this group probably constitute the collective species *Nicotiana macrophylla*. The group will therefore be referred to as the *macrophylla* group.

The plants of the second group are marked by oblong-ovate leaves, longer in comparison with their width than those of the first group. They are more pointed, often acuminate, and have the base contracted into a pandurate, very wavy and wrinkled shank, with broad, decurrent auricles. The uppermost leaves are ovate to lanceolate and long-acuminate. The corolla tube is trumpet shaped, gradually expanding from the base, with the stellate limb distinctly and often deeply lobed, with sinuate-acuminate lobes. This group is more heterogeneous than the former, and makes up the greater part of the tobacco grown in Cuba. The typical forms of this group probably constitute the collective species *Nicotiana havanensis*. Some of the less typical forms may belong to others of the older species.

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[9] LABAT, JEAN BAPTISTE, Nouveau voyage aux isles de l'Amerique. 4to ed. **2**:166. 1724; also 12mo ed. **4**:476. 1724; the edition of 1722 was not seen. See also Du Tertre Jean Baptiste Histoire générale des Antilles. **2**:99. 1667.

THE MACROPHYLLA GROUP

No. 7: pl. IV. fig. 1; pl. VI. fig. 7; pl. X. fig. 14

No. 7 is a dark green vigorous type which grew to a height of 2 m. in Cuba and 2.5 m. in Michigan. In the field growing near the other plants of the *macrophylla* group, the plants of this type stood out in strong contrast by reason of their darker color and tall growth, and their loose spreading inflorescence. The leaves are rather thick and firm in texture. This type is not liked by Cuban growers, some of whom saw it in the experimental plats.

Nos. 16 and 28: pl. VII. fig. 9

Nos. 16 and 28 proved to be identical. They are a broad-leaved type, differing from no. 7 in their dwarfer habit and more compact growth, as well as in their paler green color. The whole inflorescence is more compact than that of no. 7, and the flowers are paler. When grown side by side, these two types show a uniform and striking contrast with no. 7.

No. 18: pl. IV. fig. 2; pl. VIII. fig. 11; pl. X. fig. 15

No. 18 has the general habit and characteristics of nos. 16 and 28, which it resembles more than it resembles no. 7. This type is distinguished from the others by its remarkably large broad leaves, which are soft and flaccid, so that they appear wilted in the sun. Some plants of this type grown in Cuba during the summer season showed all the characteristics of the parent plants which had been grown during the previous winter. In Michigan the leaves grew to a very large size, but remained soft and flaccid, differing clearly from the more turgid leaves of the other forms.

THE HAVANENSIS GROUP

No. 25: pl. IV. fig. 3; pl. VIII. fig. 10; pl. X. fig. 17

No. 25 has broadly ovate or oblong leaves, arching at first and later deflexed, narrowed into a distinct pandurate, wavy, and bullate shank, which expands again into large wavy auricles terminating in long decurrent wings. The upper leaves are ovate to ovate-lanceolate and acuminate. This form may be taken as typical of the bulk of the tobacco grown in Cuba. By far the greater part of the plants in the fields belong to this type, and differ from the particular strain here described only in minor details, such as shade of the flowers, length and breadth of the leaves, and height of the plants. These minor variations, however, seem to be transmitted with great fidelity in strains descended from a single plant. Cuban growers who saw the plats uniformly picked out such types as this and nos. 36 and 37 as *Tabaco criollo*, which signifies that it is the pure Cuban. The broad-leaved types, as well as the narrow-leaved forms mentioned farther on, were generally regarded with disfavor by the Cuban tobacco growers. From these facts it seems probable that this type represents the typical Cuban tobacco cultivated in the early history of the Island and known in horticulture as *Nicotiana havanensis*.

Nos. 36 and 37

These two forms are also typical Cuban forms and differ from no. 25 only in the width and length of the leaves. The difference in width of leaves of the different strains, while very slight, was still apparent when the plants stood in groups side by side. Too much stress should not be laid on differences of this nature unless accompanied by other characteristics, or unless the differences can be clearly defined by plotting the variability curves. For all purposes, except those having in view the selection of superior strains, these types can be grouped with no. 25 as typical Cuban or Havana tobacco.

No. 12: pl. V. fig. 4; pl. VII. fig. 8; pl. X. fig. 18

No. 12 is a Cuban type, but differs from the foregoing forms in several ways, so that it was readily distinguished. The leaves were thicker, more rigid, and narrower than the other forms. In Cuba the leaves had a peculiar gray-green color which contrasted sharply with the neighboring plants. In Michigan this difference in color was less conspicuous, but all the plants of this type reacted alike as to the loss of color. The flowers are deep rose. On account of the stiffness of the leaves, their distance on the stem, and the smallness of the upper ones, the plant has an open habit quite distinct from the larger-leaved types.

No. 5: pl. X. fig. 16

No. 5 is a Cuban type with unusually broad leaves, which are obtusish at the apex, and with the shank not so distinct as in the other types. The form tends toward the broad-leaved types. The flowers are white or very pale pink, with the limb of the corolla lobed as in the other Cuban types. The plants retained all their characteristics in Michigan.

No. 32: pl. V. fig. 5; pl. IX. fig. 12

No. 32 is striking on account of its strict habit and peculiar deep bluish-green color. The leaves are of the narrow type, oblong to oblong-ovate, erect, forming an acute angle with the stem, and with the apex long-pointed and arching. The surface is marked with furrows and the pandurate base is much wrinkled. The flowers are deep pink to pale pink, with triangularly lobed limb. The strict habit and thick leaves of dark bluish-green color make these plants very conspicuous in the field. The characteristics of the plants were retained in Michigan.

No. 1: pl. V. fig. 6; pl. IX. fig. 13; pl. X. fig. 19

All through the Cuban tobacco fields there occur narrow-leaved forms which resemble the ordinary Cuban types to some extent, at least while they stand intermingled with them. It is all the more difficult to separate these forms definitely because a number of gradations occur from very narrow leaves to much wider-leaved forms approaching the typical Cuban tobacco. These forms do not constitute a large percentage of the tobacco crop. They are sufficiently conspicuous, however, to have attracted the attention of Cuban growers, who call such forms *lengua de vaca* or cow's tongue. A number of such forms varying in width of leaves were selected, but seeds were obtained from only one form. The others failed to produce suckers. No. 1 is a conspicuously narrow-leaved form. The plants are of dwarf habit, having the large leaves low down on the stem, thus giving the upper part a naked appearance. The leaves vary from oblong-pointed to lanceolate-acuminate. The surface is wavy, being obliquely furrowed parallel to the veins. The base is narrow-pandurate with decurrent auricles. Inflorescence loose, open. Limb of the corolla deeply lobed, with ovate or triangularly acuminate lobes. Color pale rose to deep rose. In Michigan the form retained the same dwarf habit, with the large leaves on the lower part of the stem. The only difference was that the plants grew more vigorously and had larger leaves in the northern habitat. Types like this and no. 32 differ very conspicuously from the other members of the *havanensis* group, and it is possible that they belong to other species.

Conclusion

The tobacco grown in Cuba consists of a mixture of a large number of forms which maintain their characters from generation to generation. Pure strains, breeding true to type, can readily be selected from this mixture. When such pure strains are grown in northern climates, they do not break up into a number of new types, but the plants of each strain remain uniform. Such modifications as appear, appear alike in all the plants of a given strain.

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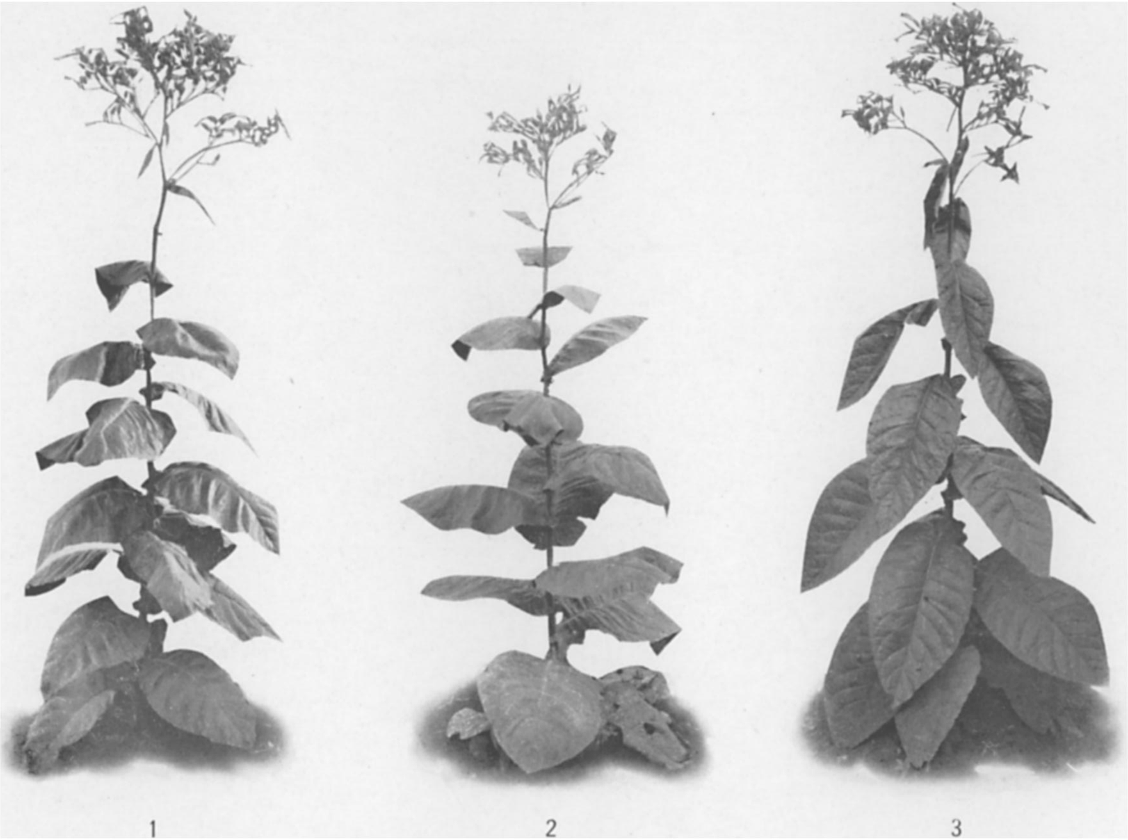
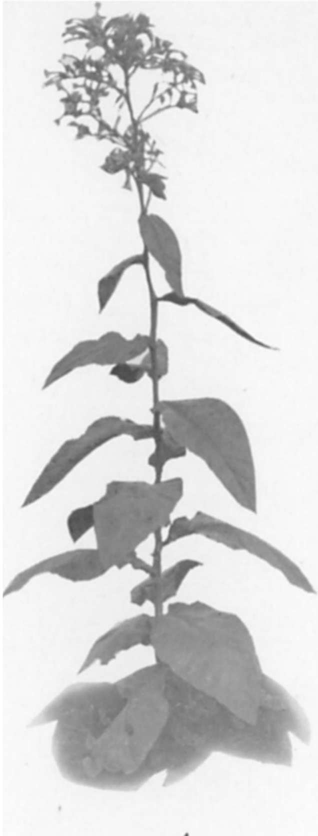


HASSELBRING on CUBAN TOBACCO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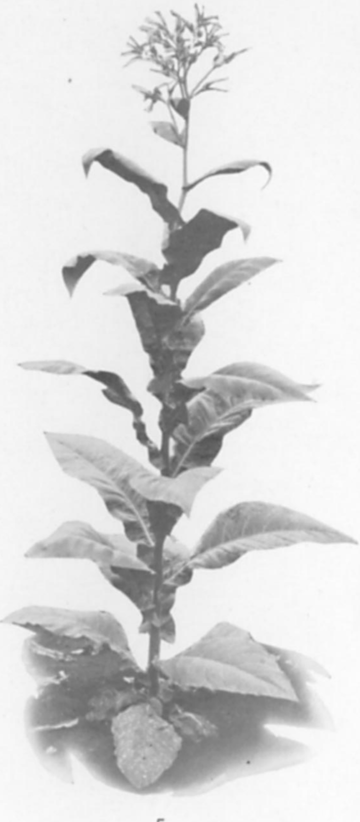
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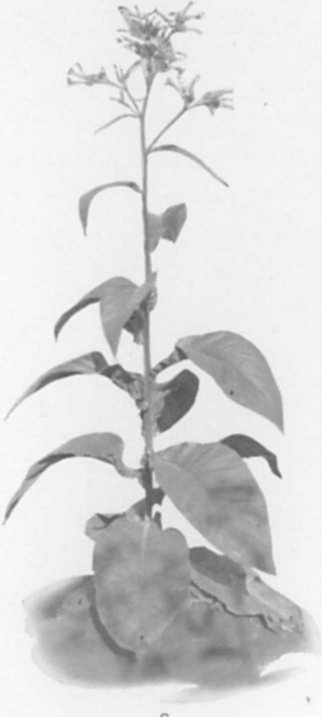
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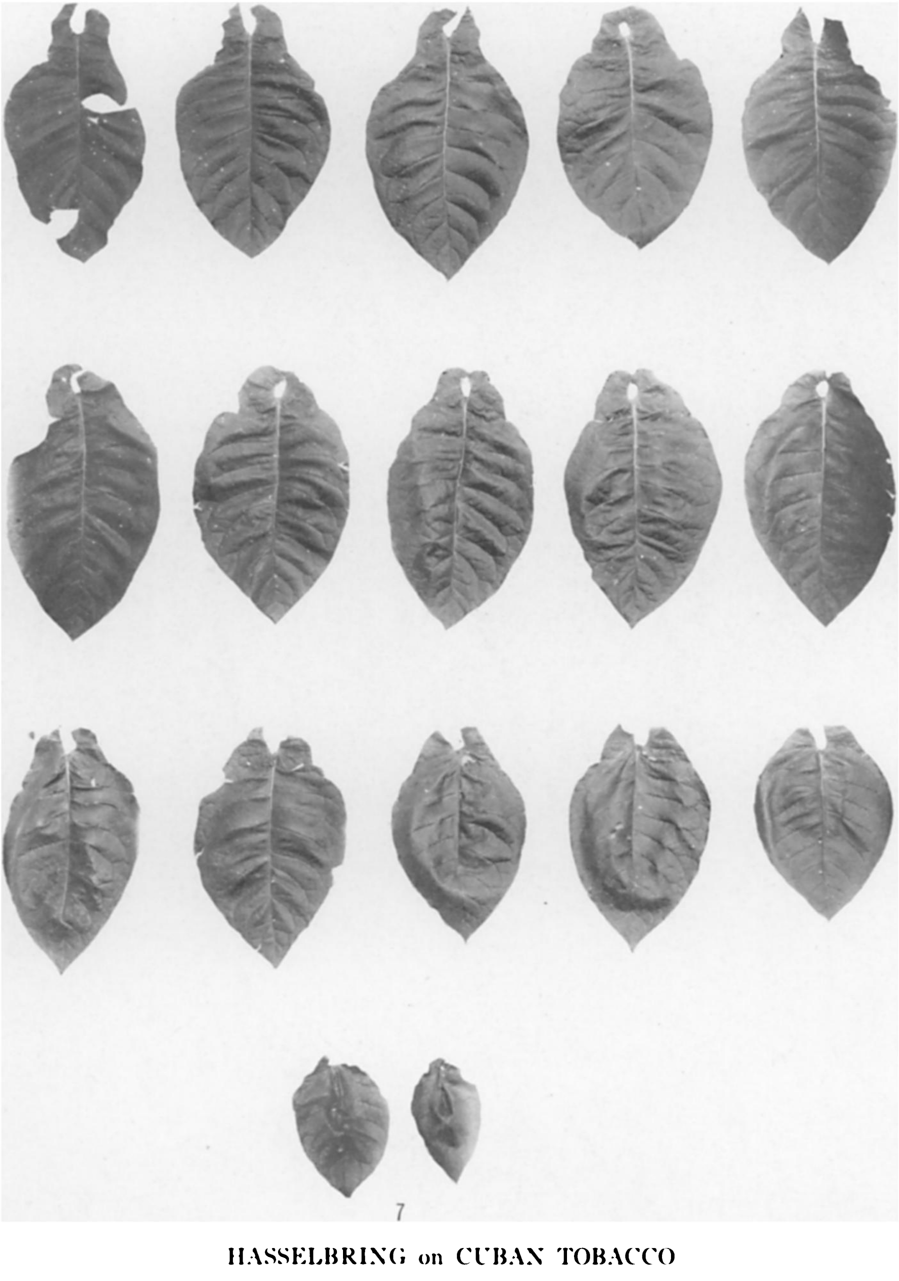

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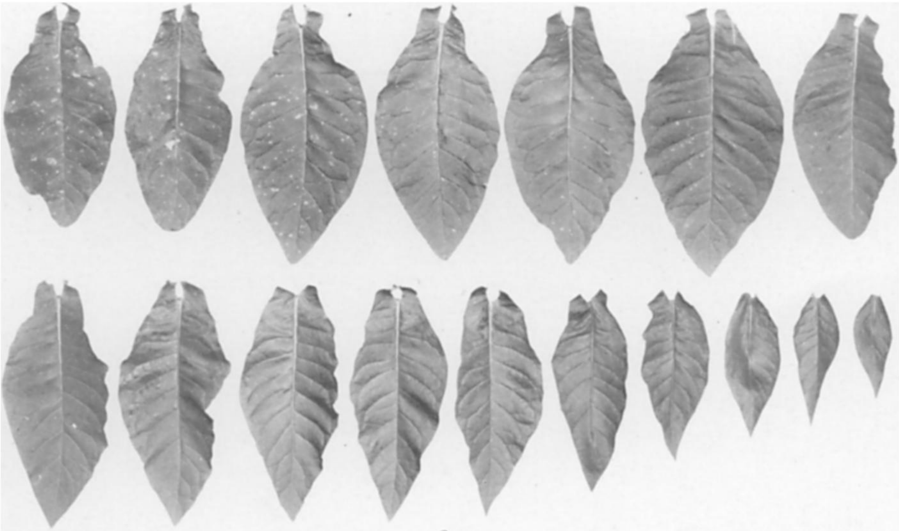

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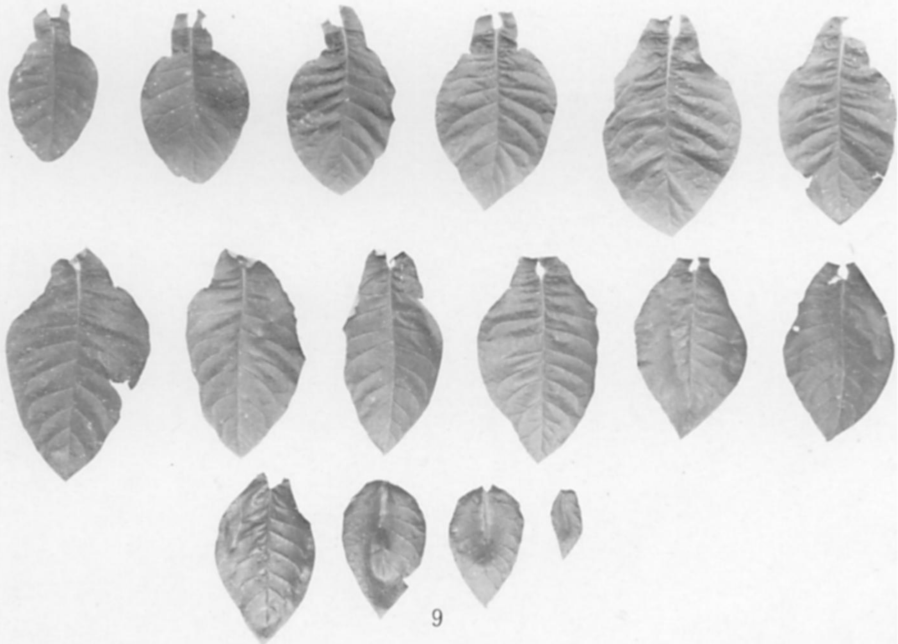

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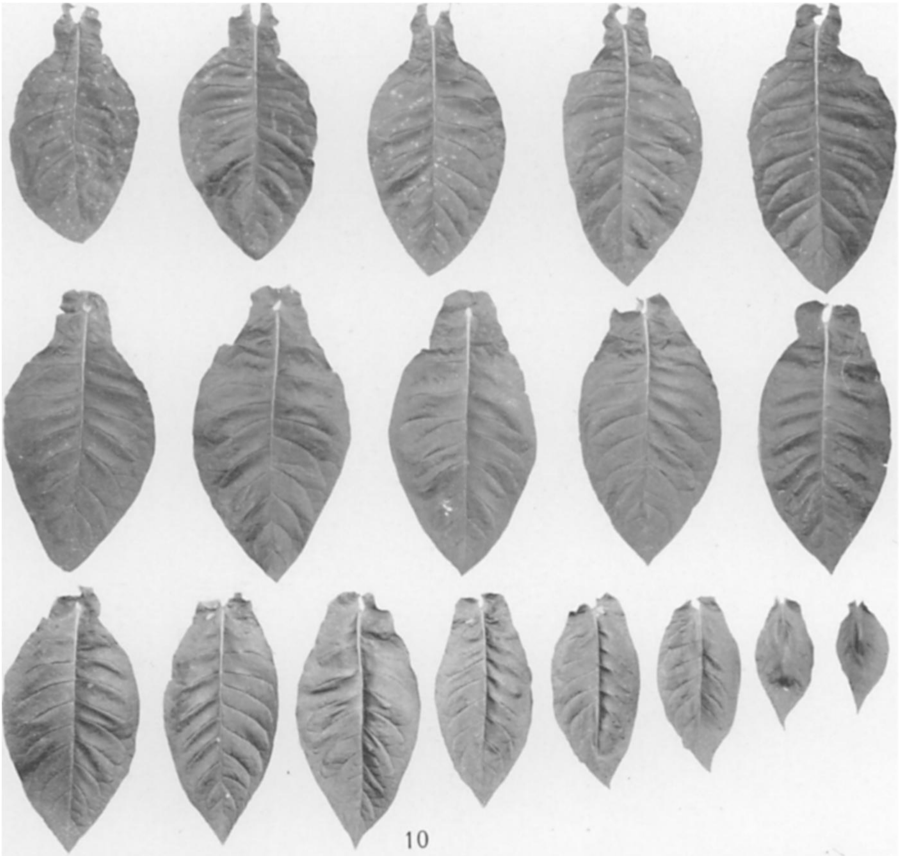

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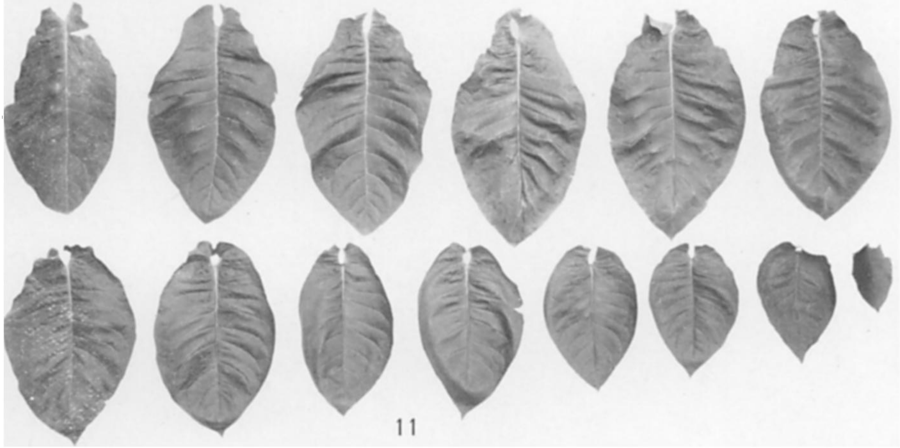

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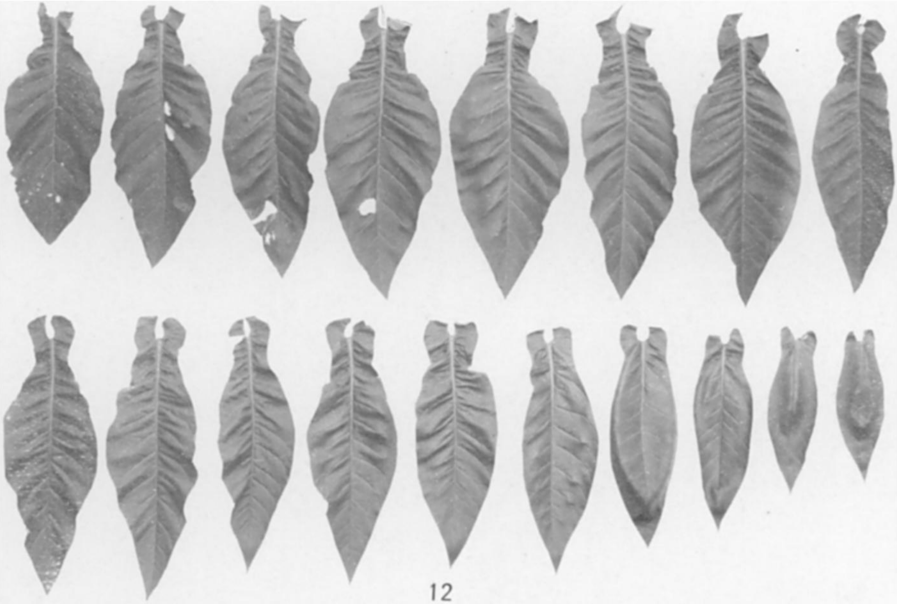

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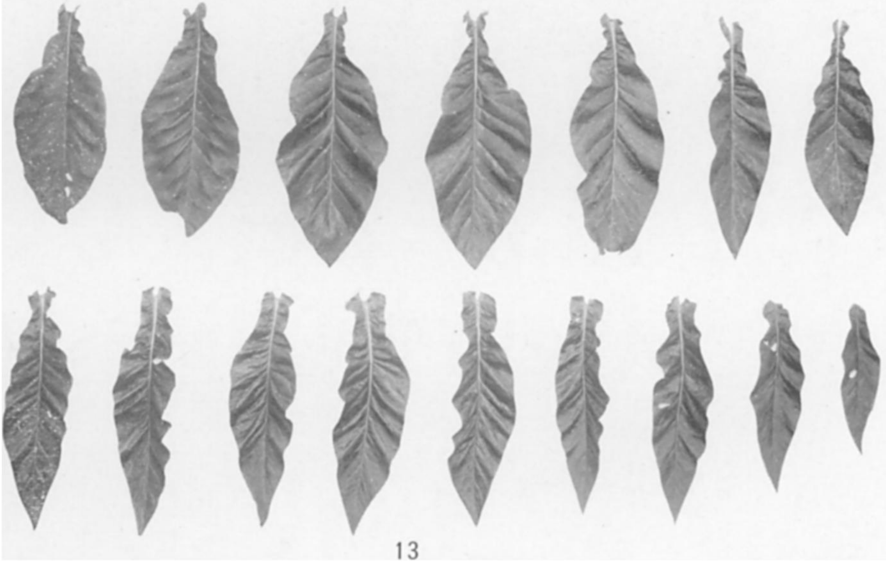

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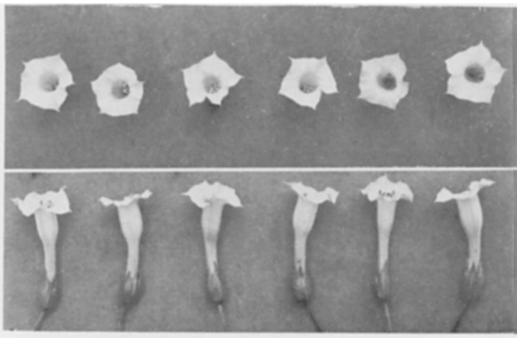

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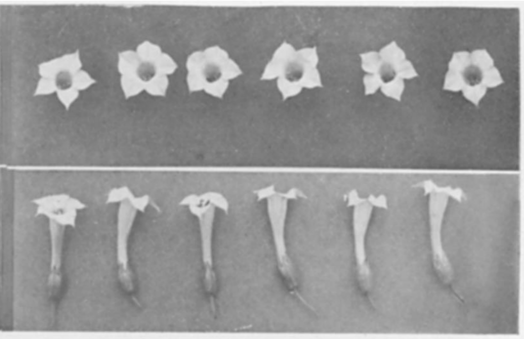

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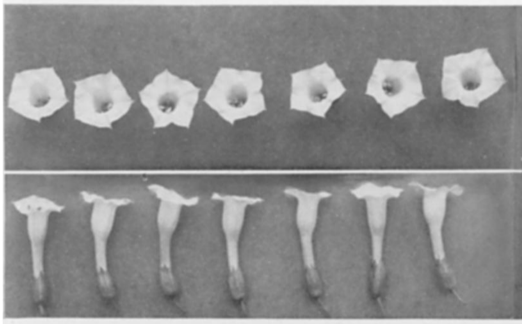

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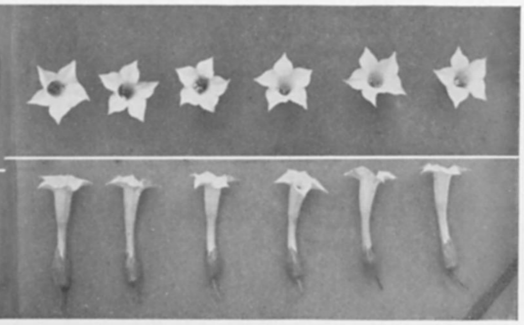

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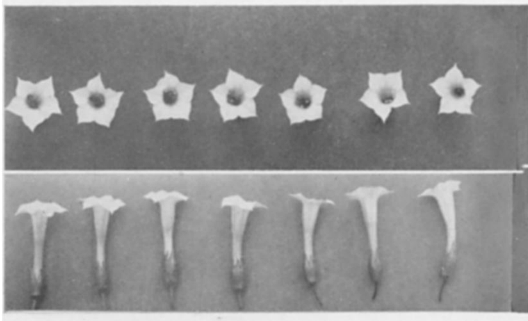

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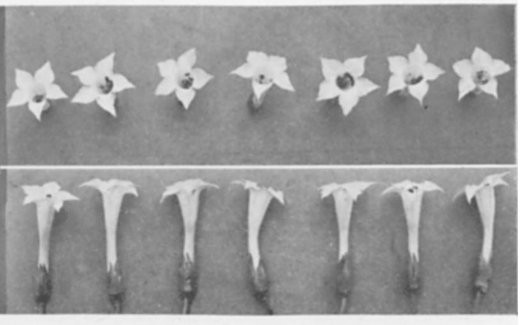

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HASSELBRING on CUBAN TOBACCO